DOCUMENT RESUME

ED 208 865 IR 009 778

AUTHOR Leach, Tom
TITLE Some Ergonomic Considerations of VDU Workspaces at D. H. Hill Library.
PUB DATE 81
NOTE 18p.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Display Systems; Furniture Design; Glare; Health Needs; *Human Factors Engineering; *Library Personnel; Questionnaires; Surveys; *Work Environment
IDENTIFIERS *Health Surveys; *North Carolina State University Raleigh

ABSTRACT

A study conducted to investigate possible health problems resulting from employees' use of visual display units (VDUs) in the library of North Carolina State University at Raleigh used a survey to identify the kinds of tasks performed at each VDU workstation and the rate of health complaints. Analysis of the tasks performed in the library indicates that all of the VDUs are functionally conversational terminals. Among the significant number of health complaints reported, the most frequently specified were visual complaints. Suggestions of ways to minimize these and other complaints, compiled for distribution to workers and department heads, are included in this report, as well as a copy of the questionnaire. Twenty references are listed. (LLS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED208865

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

[X] This document has been reproduced as received from the person or organization originating it.

[ ] Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

SOME ERGONOMIC CONSIDERATIONS OF VDU WORKSPACES AT D.H. HILL LIBRARY

Tom Leach

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
John T. Leach

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

IR009778

Abstract

A survey was employed to investigate the kinds of tasks performed and rate of health complaints at each VDU workstation at the D.H. Hill Library, N.C.S.U. at Raleigh, N.C. . Through discovery of what tasks are performed at D.H. Hill, it was determined that all VDUs were, functionally, conversational terminals. A significant number of health complaints arising from VDU use was found. Suggestions to minimize health complaints were written and distributed to workers and department heads.

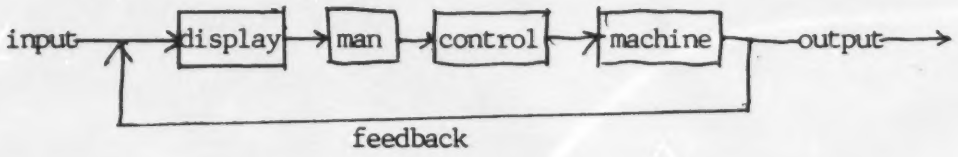
Some Ergonomic Considerations of VDU Workspaces at D.H. Hill Library

To aid in the organization and expedition of the great amount of information available today, computer-controlled devices are now a necessity for small offices as well as large corporations and research complexes. The prevalent class of computer-controlled displays in use is the cathode ray tube (CRT). (Gould, 1968., Grandjean, 1980.) There are an estimated 5-10 million visual display units (VDUs) and more than 7 million operators in the United States alone.(MMWR,1980.) The large majority of these VDUs are of the cathode ray tube type. With such a large number of VDUs being employed daily, it is important to consider the possible health effects of their use.

A 1980 NIOSH publication (MMWR,1980.) reports that significantly higher levels of visual and musculoskeletal complaints were found in workers at VDUs than in a control group consisting of workers employed in traditional office activities. Significantly higher levels of psychological stress, anxiety and irritability were found, as well. These problems do not contribute to the worker's comfort, job satisfaction or productivity. The health complaints often cited by workers at VDU stations, are sometimes persistant after working hours.(Grandjean,1980)

The present study is an investigation of possible health problems resulting from the use of VDUs at D.H. Hill Library. VDUs are employed primarily as conversational terminals at D.H. Hill Library. Grandjean (1980) draws a distinction between conversational terminals and data-entry terminals.

The conversational terminal is characterized by data entry through a keyboard to the computer, with the results appearing later on the screen. The gaze of the operator is on the screen about 50% of the time, and on the source document 50% of the time. A low stroke speed on the keyboard is usual at conversational terminals. This describes a closed-loop system and can be illustrated by a diagram found in VanKott and Kinkade.(1972)



The operator reacts to the stimuli on the VDU, makes a decision and carries out certain responses which affect the controls (keyboard). This takes a new set of stimuli information to the VDU. There are certain psychological aspects involved in working at VDU workstations. The employee becomes part of a man-machine system. His personal radius of action becomes restricted, and sometimes an increase of performance and work becomes more monotonous. Some employees fear new technology and automation which may lead to a negative set of attitudes toward work at VDUs. The manner in which an employee's first training procedures at a VDU are administered can contribute to a set of attitudes about VDUs. All of these psychological aspects are varied upon the type of work, job organization, the way VDUs are introduced and various personal attitudes. (Grandjean,1980.)

VDU operators specify visual complaints more often than any other kind of complaint. (Grandjean, 1980. NIOSH, 1981.) Tasks at VDUs involve specific visual considerations which are different from traditional office work. Illumination levels in the office have risen dramatically over the past fifty years, disproportionately to the actual illumination requirements of office work.(I.B.M.,1978. Gustafsen, et.al.,1976.) This higher illumination level in VDU workplaces, does not seriously affect the visibility of characters on the screen if the higher brightnesses are not more than 100 times as bright as the average brightness of the VDU screen. This range of illumination easily facilitates comfortable reading of the source document as well as characters on the screen. According to Military Standard 1472 A, ambient illumination on the VDU screen should be appropriate for other visual functions, but should not interfere with visibility on the VDU. A general consideration that all sources agree upon, is that an imbalance in light levels when looking from the screen to the source document, requires the eye to adjust to disproportionate light levels. A momentary reduction in contrast sensitivity occurs when the point of fixation is shifted to a point of different luminance. For example, a 10 to 1 difference results in a 25% momentary reduction in contrast. (I.B.M.,1978)

As well as adaptation complaints, problems of accomodation and convergence often arise. These problems are a result of focusing images at varying distances and involve eye muscle control. Accomodation is made difficult at VDUs because of unsharp boundaries between the characters and the background of the screen. Since this is a design consideration and cannot be corrected on VDUs presently employed, NIOSH (1981) suggests frequent eye examinations and certain eye excercises.

When correcting for adaptation problems through compatible illumination levels, considerations must also be made for controlling flicker effects from

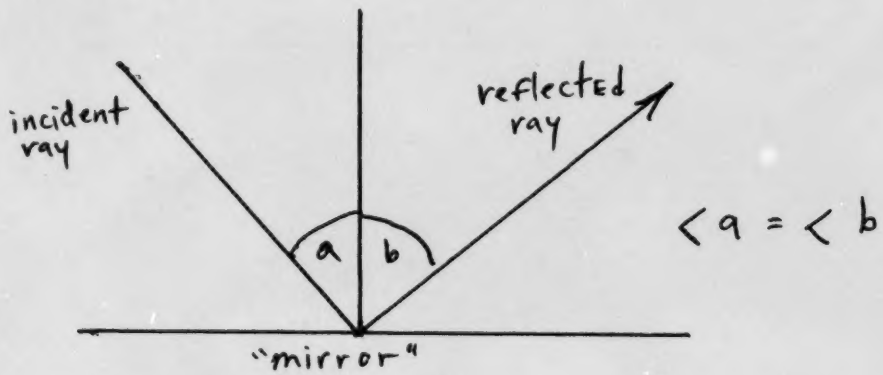
the screen. Flicker occurs because of raster scan phosphor oscillation. Technology employing alternate lines of firing electrons and other methods have helped to reduce flicker, but many VDUs in the workplace are of the older types and must be considered. Flicker can cause adverse ocular effects due to overloading of adaptation and overexposure of the retina to light.(Grandjean, 1980.) There is conflicting information concerning the minimization of flicker effects from VDU screens. Grandjean(1980) states that the flicker effect is increased with a low background luminance of the screen and a low illumination level in the workplace. I.B.M.(1978) and Welde, et al.(1972) report, conversely, that an increase in flicker effect occurs as office illumination is increased. These sources suggest that lowering both the general illumination level of the office and the brightness of the VDU screen will minimize flicker effects.

All sources agree, however, that reflections and glare can cause problems with VDU employment. Generally, a distinction is drawn between two types of glare; direct glare and specular glare. Direct glare occurs when light from windows and light fixtures enter the visual field of the operator and direct into his eyes. Specular glare is that light reflected from work surfaces, screen, floors, walls and ceiling. Disability glare occurs when a significant amount of light is spread across the foveal area and reduces the contrast of the object of vision. Discomfort glare, in the case of VDUs, results from differences in luminance between screens and light surfaces in the room. (Boyce,1979. Hultgren and Knave,1974.)

Screen orientation can minimize most reflections if the law of reflections is taken into consideration. The angle of the incident ray is equal to the angle of reflection. (Frye,1974. Leebeek,1978.) See fig.1.

Figure 1.

The Law of Reflection (from Frye,1974.)



If the windows in the workplace cannot be shielded, screens should be placed perpendicular to the windows. Some workers attach hoods to reduce specular glare, but some reports suggest that they have little effect upon glare and often produce an uneven background luminance. (again, accomodation problems) The top of the display may be darker than the lower portion, causing uneven illumination on the screen itself.(I.B.M.,1978.) Using dull matte finishes on work areas, avoiding layouts with direct light entering the visual field, location of the screen vertically below eye height, and covering the windows from sunlight will all minimize glare and reflection problems.(Grandjean,1980. Leebeek,1979. I.B.M.,1978. and NIOSH,1980.)

The next greatest percentage of VDU operator complaints is usually postural. (Grandjean,1980.) Human variability must be taken into account when laying out workrooms with VDUs. The first basic layout reference point to consider is the eye position relative to the task. (VanKott, et.al., 1972.) The seat and desk height should be adjustable to allow the screen display to fall within 30 degrees of the normal line of sight.(10 degrees below horizontal) VDUs are sensitive to parallax and should be designed to have a 90 degree screen angle.

Constrained posture at VDUs is attributed to the fact that the head and hands are kept in a practically fixed position. The head position is determined by the visual distance to the screen or source document. The position of the hands is determined by the keyboard. (Grandjean, 1980.) The posture assumed by many VDU operators was found to be characterized by the trunk leaning back as the neck leaned forward. The shoulders are held high, arms extended forward and the forearms at a high level between the shoulders and elbows. Some reasons that Grandjean offers for this nearly typical posture are that; there is no proper support for the forearms and hands, there is no proper support for the source document and it is often too low, and improper backrests are used in seating. The source documents should be supported at a 15 degree angle and at a suitable height to prevent excessive foreward angles of the head and neck. Backrests, Grandjean suggests, should be high er (45-50 cm.) to facilitate support of the spine while assuming the necessary visual distance from the screen. Higher backrests along with adjustable seat inclination, resulted in improved posture at VDUs, in one Grandjean study(1980.).

Although some researchers report suggested workplace dimensions,(Luczak and Rohmert, 1978.) Grandjean feels that more studies must be made concerning specifically VDU workplaces before workplace dimensions are suggested. However, general criteria for good posture can be considered when making considerations . Good posture should result in even pressure on the spine. The backrest should support the inward curve of the lower spine and take some weight from it. The head and neck should not be excessively bent downward Most of the body weight should be upon the buttocks rather than the thighs Seat height adjustments should leave the thighs nearly horizontal and the feet flat on the floor, or on foot rests if necessary to maintain the proper visual angle. (Kroemer,et.al. 1968. I.B.M., 1978.)

Maximum flexibility should be maintained in VDU workstations to allow for: keyboard height, screen height, brightness and contrast of the screen, viewing distance, chair height, desk height, leg room and individual illumination levels of the workspace. Because individuals posessing a variety of body dimensions may use the same VDU at different times during the day, it is very important to leave a large amount of flexibility of adjustment for all of the mentioned dimensions.

In this pilot study at D.H. Hill Library, all seven workplaces under consideration were installed with no ergonomic consultation. Many layouts are a result of available space and shared functional arrangements. Trial and error set ups with screens and hoods were employed at several stations. Two hypotheses for this study might be stated;

A significant number of health complaints will be expressed by workers at all seven VDU workstations, and the more time a worker spends at the VDU workstation, the greater number of resulting health complaints.

Method

Subjects

45 female and 1 male operators, employed at D.H.Hill Library for at least 1 year and using the VDUs for some amount of time each day. Ages range from 18 to 53 years. The only selection variables were that subjects will have been employed at the VDUs for a least 1 year, and that they use the VDUs every day for some amount of time. These criteria excluded occasional users or new employees.

Instrument

A survey was given to subjects to identify the number and sources of health complaints perceived while using VDUs. While a subject's

perceptions may vary from day to day, the survey was designed to detect an overall feeling about the tasks at the VDU, which should remain the same over time. The first part of the survey contains questions which determine whether the subject uses the VDU as a conversational terminal or as a data-entry terminal, and some idea of the nature of the work rhythm required for library tasks. The second part of the survey was a three-step scale used to determine the rate of health complaints and whether the complaints related to visual or postural problems.

Procedure

The subjects were contacted informally and questioned concerning their feelings about work at VDUs. Most subjects expressed a strong interest and enumerated several types of complaints. The informal interviews led to a survey design. After receiving departmental approval, the surveys were administered to the subjects to fill out at their leisure. The workplace dimensions were measured and workplace arrangements were observed, charted and photographed.

Results

There was no control group or measurement of the subjects over time in this preliminary study of VDU workplaces at D.H. Hill Library. Statistical analysis can show only variance within this subject group. Given these limitations, some statistical data still proves indicative. Ordinal data from eye,back and neck complaint questions were assigned values:

almost every day= 3

occasionally = 2

never = 1

Statistical treatment of ordinal data is philosophically justified by

Coombs (1953). He stated that since a scalar relationship of this type describes a measurable relationship, it is valid to apply statistical methods. The values assigned to the ordinal health values are used to find the mean value of health complaints. Mean values for time are of course, treated as interval data. The overall mean time spent at VDU stations was 1.7 hours, with a maximum value of 5 hours and a minimum of 1 hour. The combined mean score for health complaints of eye, back and neck, was 6.3. This value falls in the range of "ocassionally". A total of three "ocassionally" values equals 6. This mean figure could also be attained through an overall combination of scores on health complaints with a range from value 3 (3"nevers")to 9 (three"almost always").
In table 1, the workspaces were rated individually by total mean health values.

Table 1.

workspace	mean health value	stan. dev.	problems & observations
7(periodicals)	8.25	1.5	white walls in front ofVDU direct light,2 ft. rt. side (adj. chair, fixed 15 in.)
3(reserve)	7.80	1.3	traffic area, stat.chair 15 in.
4(Acq.)	6.5	2.14	direct light from window on lt. overhead lighting behind and front (adj. chair, fixed 15 in.)
1(cat.)	6.07	1.49	lighting from behind, traffic area (adj. chair, fixed 17 in.)
5(Ill)	6.0	1.22	lighting from right, traffic area facing window over study area (chair adj. fixed ,16 in.)
2(Lib.sys.)	5.6	1.5	light from window on rt seat stat. 17 in
6(serials)	5.0	2.44	no overhead light at all screens, chair adj. 14 in.

This ranking suggests a difference in the workspaces, with standard deviations perhaps, indicating individual differences worthy of further analysis to determine why the workspaces differed in health complaint rates compared to workspace layout problems.

An attempt to determine individual workplace differences in kind of health complaint by time, and by workplace with chi-square tables proved fruitless, because over 5% of the cells contained expected counts of less than 5. Correlation coefficients showed a slight relationship between the amount of time spent at a VDU and the rate of health complaints. r= .20686 for health*time. A cause and effect relationship between time and rate of health complaints is not indicated because of other workplace variables that are present.

Discussion

The findings of the present investigation indicate a need to make adjustments available in almost every workplace. Even those workplaces with a mean health complaint value of below "ocassionally" contained some workers with a higher complaint rate (as indicated by the standard deviations). Unfortunately, the workplaces are functionally non-adjustable at the present. It would be valuable to determine,through anthropometric measures, if it is the percentage of workers for whom the workplaces are improperly adjusted who suffer from the highest rate of health complaints. As a part of this study a list of general recommendations was prepared and distributed to each department. (See appendix IV) A future study might be to make orientation adjustments to each workplace, inform the workers of their best seat height, screen height, etc., and then readminister the survey to the same subjects as well as to a control group.

Major problems in the D.H. Hill Library VDU workplaces are:

1. fixed desk heights
2. seats are difficult to adjust
3. improper source document supports
4. administrative problems when moving VDUs such as, rewiring the terminals, etc.

Some General Recommendations Applicable to Visual Display Workplaces

Visual Considerations

-to minimize reflections and glare:
Orient the screen to be perpindicular to windows.
cover windows, if necessary.
avoid direct light from windows or fixtures, entering the visual field
use dull matte finishes on the working areas.

-to minimize flickering effects:
install individual light controls for each operator to make adjustment to his required lighting needs.

Postural Considerations

-to minimize neck and back complaints:
place the source document at a comfortable height, supported at a 15 degree angle on the work surface.
Orient seat height, or screen height, so that the screen is nearly horizontally in front of the eyes, in a normal working position.
Adjust your backrest so that the inward curve of the spine is supported.
Adjust your seat so that your thighs are nearly horizontal when your feet are flat on the floor, or a foot rest. Your thighs should not bear body weight.
To maintain a proper visual angle to the screen, it may be necessary for some operators to use foot rests and adjust the height of the screen by raising or lowering the desk height. Unfortunately, desk heights on standard office equipment is not adjustable.

Specific Problems at D.H. Hill
-seat heights are not convenient to adjust and may be fixed at a level that is comfortable for only a few operators.
-Most workers are at the VDU for only two hours, and may feel that it is too much trouble to make proper adjustments.
-Where screens are oriented improperly with respect to light fixtures and windows, facilitating direct and specular glare, it is difficult to move the terminals without administrative action. ie: rewiring terminals getting Physical Plant work orders for moving them, etc.
-There are no proper supports for forearms and hands in existing equipment
-There are no proper supports for source documents in existing equipment.

References

Boyce,P.R. Veiling Reflections: An Experimental Study of Their Effects on Office Work. Electricity Council Research Center, Capehurst, England, March, 1979. (PB-80-126-261).

Byers,B.B.,Hritz,R.J. & McClintock, J.C. "Industrial Illumination". Industrial Hygiene, Engineering and Control. U.S.Dept.H.E.W.,Nov.1978.

Frye,G.A. "Ocular Discomfort and Other Symptoms of Eyestrain at Low Levels of Illumination". The Occupational Safety and Health Effects Associated With Reduced Levels of Illumination. Symposium, Cinn. Ohio. July, 1974.

Gould,J.D. "Visual Factors in the Design of Computer-Controlled CRT Displays". Human Factors, August, 1968, pp.359-375.

Grandjean, E. Ergonomics of VDUs: Review of Present Knowledge, London, Taylor & Francis,Ltd.,1980.
Fitting The Task to the Man, An Ergonomic Approach. London, Taylor & Francis, 1979.

Gustafsen,P.C., Aschenbach,J. & Sulzer, R.L. Plain View Display Background Lighting. U.S.D.O.T., F.A.A., May,1976.(AD A024 954).

Hultgren,G.V. and Knave, B. "Discomfort Glare and Disturbances From Light Reflections in an Office Landscape with CRT Display Terminals". Applied Ergonomics, 5.1,2-8, 1974.

I.B.M., Human Factors of Workstations with Display Terminals. San Jose, Calif., Human Factors Center. IBM publication #G 320-6102-0, 1978.

Kroemer, K.H. & Robinette, J.C. Ergonomics in the Design of Office Furniture, A Review of European Literature. Ohio, July, 1968. (AMRL-TR-68-80)

Leebeek, H.J. Some Ergonomic Aspects of Adapting Workrooms with Visual Display Units to the Human Possibilities . Institute For Perception, Soesterberg, Netherlands, 1978. (N79-17562-6). Translated for me by Astrid DeMont.

McCormick,K.J. Human Factors in Engineering and Design. McGraw-Hill,1976.

Military Standard, Human Engineering Design Criteria for Military Systems Equipment, and Facilities. Feb. 1968.

NIOSH, "Working With Video Display Terminals: A Preliminary Health-Risk Evaluation". Morbidity and Mortality Weekly Report, v.29, #25,June,1980.

Roe, W.T. & Finely,D.L. Ergonomic Models of Human Performance: Source Materials for the Analyst. Manned Systems Sciences, Inc., Northridge, Calif.,1975.

Rohmert, W. & Luczak, H. " Ergonomics in the Design and Evaluation of a System for Postal Video Letter Coding". Applied Ergonomics,9.2, 85-95, 1978.

Smith,M. P.B.S. Broadcast on Office Environment, March,1981. NIOSH study to be released in 1981.

Uhlaner, J.E. Questionnaire Construction Manual. U.S.Army Research Institute for the Behavioral and Social Sciences, Fort Hood Field Unit, 1976.

Vanbott,H.P. & Kinkade,R.G. Human Engineering Guide to Equipment Design. American Institute for Research, Washington,D.C.,1972.

Welde, W. & Cream,B. Variables Influencing the Perception of Flicker in Wide Angle CRT Displays. Air Force Human Resources Laboratory, Ohio, 1972. (AFHRL-TR-72-4).

Secondary Reference

Nie,N.H. Statistical Package for the Social Sciences. Coombs(1953) p.6. 2nd. Edition, McGraw-Hill,1975.

APPENDIX I.

Survey Instrument

WORKPLACE QUESTIONNAIRE

This first section concerns health complaints arising from the use of Visual Display Terminals. Please place a check besiden the response that most correctly describes your perceptions.

1. Do you work entirely from information displayed upon the viewing screen? _Yes _No

2. Do you use a paper source in conjunction with information displayed upon the viewing screen? _ es _No

3. Is your work of a non-stop continous nature? _Yes _No

4. Can you find your own individual work rhythm with short pauses away from the screen? _Yes _No

5. Does the nature of your work require you to use the keyboard? _Yes _No

6. If so, how much of your time at the terminal is spent using the keyboard?

__ 10% __30% __50% __ more than half the time

7. On an average, how much time do you spend working at a terminal in a day?

__1 hr. or less __2 hrs. __3 hrs. __4 hrs. __5hrs. __more than 5 hrs

8. After working at a terminal, do your eyes feel:

	__almost every day	__occasionally	__never
tired			
gravelly	__	__	__
strained	__	__	__

9. After working at a terminal does your back feel:

	__almost every day	__occasionally	__never
stiffness			
aches	__	__	__
cramps	__	__	__

10. After working at a terminal, does your neck feel:

	__almost every day	__occasionally	__never
stiffness			
aches	__	__	__
cramps	__	__	__

11. After working at a terminal,do your hands feel:

	__almost every day	__occasionally	__never
stiffness			
aches	__	__	__
cramps	__	__	__

12. After working at a terminal, do your fingers feel:

	__almost every day	__occasionally	__never
stiffness			
aches	__	__	__
cramps	__	__	__

WORKPLACE QUESTIONNAIRE (pg. 2)

13. After working at a terminal, do your arms feel:

stiffness	__almost every day	__occasionally	__never
aches	__	__	__
cramps	__	__	__

14. After working at a terminal, do your legs feel:

stiffness	__almost every day	__occasionally	__never
aches	__	__	__
cramps	__	__	__

15. Do you experience glare on the screen from:
    __windows
    __overhead lights
    __lighting from behind